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*Grössenschätzungen im Gesichtsfeld.* von DR. R. FISCHER. *Archiv für Ophthalmologie* (1891).

The investigation of this subject occupies two articles, one in the first and the other in the third number of the *Archiv*. It represents two different sets of experiments. The first article is devoted to those on the ocular measurement of lines, and the second to the measurement of angles.

In the measurement of lines the experiments were directed in two different ways. The first method was to divide a given line into two equal parts, and the second to make a line equal to a given one. The arrangement for effecting these results consisted of two lines representing a cross, and placed upon a dark background. The intersection of the two lines formed the point of fixation. The whole of the lines forming the cross was at no time visible, but only such portions of them as were to be compared or divided. An apparatus was arranged to mark off the portions desired for this end. The comparisons were made between the upper and lower and the right and left arms of the cross. One arm was given and the effort was to mark off on the other arm a line equal to the given one, and again to divide a given arm into two equal parts. The experiments were conducted first with both eyes and then afterward with the right eye alone.

The experiments comparing the two vertical arms always showed that the lower arm was overestimated. Out of 560 attempts to divide the vertical arm equally, the average error was 6.70 mm. This result, indicating the difference between the two arms, is expressed by the following proportion: Lower arm : Upper arm :: 100 : 106.70. We may say here that the ratio is against the lower arm. In 128 attempts to make the two arms equal, the average error was 3.22 mm. against the lower arm. The proportions could be formulated as before. In comparing the horizontal arms the constant error was very slight, so slight, indeed, that the estimation was almost exactly correct. In 560 trials at halving a horizontal arm, the average error was only 0.79 mm. against the left arm, the proportion between the two arms being: Left : Right :: 100 : 100.79. In 680 attempts to make the two horizontal arms equal, the average error was only 0.73 mm. against the right arm when the given arm was on the left, and 0.43 against the left when the given arm was on the right. The results here seem to show very distinctly a greater accuracy in the estimation of linear magnitudes by the interior and exterior, or horizontal, than by the superior and inferior, or vertical, muscles of the eyes.

In experiments comparing the vertical and horizontal arms of the cross, the lower arms were considerably overestimated. In 960 trials comparing the lower vertical with the horizontal arm, the average error was 14.67 mm. against the lower, and in 800 trials, comparing the upper arm with the horizontal, the average error was 11.66 mm. against the upper vertical.

The experiments in monocular vision were no less interesting. In 950 attempts to make the vertical arms equal, the average error against the lower arm was 5.63 mm., and in the same number of trials to make the horizontal arms equal, the average error was 3.24 mm. against the right arm. The inference in these cases would be much the same as before, namely, the superior accuracy of vision in the horizontal lines. In 280 experiments comparing the lower vertical with the horizontal arms, the average error was 18.19 mm. against the vertical when the left horizontal was taken, and 15.14 mm. when the right was taken. In 280 trials comparing

the upper vertical with the horizontal, the average error was 10.83 mm. against the vertical when the left horizontal was taken, and 7.70 mm. against it when the right was taken. Here, again, the results show the greater overestimation of the lower arm of the cross.

The results at large are very well summarized in the following manner: First, in regard to the correctness of the estimates of magnitudes, the comparisons of the horizontal arms of the cross with each other by both eyes were the only cases approximating accuracy. In the other cases, (1) the lower arm compared with the upper, was uniformly overestimated; (2) the right arm compared with the left was overestimated; (3) in comparisons of the vertical with the horizontal arms, the lower was overestimated more than the upper vertical. Second, the results also show (1) that the estimates follow the psychophysical law, and (2) that the variable error was only half as great in dividing as in comparing lines, a fact which is construed as proving the practicability of the method of the least observable differences.

In the second paper, describing the experiments for comparing and measuring angles, a circle about 36 cm. in diameter was drawn upon a dark background. This circle was divided accurately into definite portions of thirty degrees each, and these marked by threads issuing from the centre and movably fixed in the circumference. The experiments consisted in efforts to divide a given angle in one of the quadrants into equal parts. Assuming the centre of the circle as the point of fixation, the results would show, as in the case of the cross, the capacity of different portions of the eye for judging magnitudes. The mean or average error was assigned in terms of the percentage of the real half angle to be guessed, and marked with a plus or minus sign, according as the eye judged a quantity larger or smaller than the proper one. The first set of experiments was with the right eye, and the second with the left. The results showed perfect similarity between the two eyes, and were summed up by the author in the statement that "when the angle to be bisected was horizontal or approximately so, the upper angles were overestimated, and the lower underestimated." This was true of both halves of the visual field. The experiments represented attempts to halve angles varying from 10 to 150 degrees. Another and distinct set of experiments were efforts to divide 180 degrees equally, beginning at different points in the circumference. The results were practically the same for each eye, and were very striking in one respect. Beginning at zero, which was the terminus of the vertical diameter in the upper half of the circle, and proceeding to the right with every ten degrees as a starting point for the 180 degrees to be divided, the average error was always plus until seventy degrees were reached, when it became minus and remained minus until 150 degrees were reached, when it became plus again up to 180 degrees. Beginning at zero, or 360 degrees, again, and proceeding to the left, the same distances showed similar results. From 360 to 290 degrees, the average error was plus, and then became minus until 200 degrees were reached, when it was plus to 180. This means that the upper quadrants were overestimated in most cases, and the lower quadrants underestimated in most cases.

J. H. HYSLOP.

*Ueber Fusionsbewegungen der Augen beim Prismaversuche.* von ALFRED GRAEFE. Archiv für Ophthalmologie (1891).

The object of the author is to throw light by special experiments on the question whether binocular accommodation is native or em-